

ϕ(1020)

$$I^G(J^{PC}) = 0^-(1^{--})$$

ϕ(1020) MASS

We average mass and width values only when the systematic errors have been evaluated.

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1019.417 ± 0.014 OUR NEW AVERAGE		Error includes scale factor of 1.8. See the ideogram below. [1019.413 ± 0.008 MeV OUR 1998 AVERAGE]		
1019.36 ± 0.12		1 ACHASOV	00B SND	$e^+e^- \rightarrow \eta\gamma$
1019.504 ± 0.011 ± 0.033	314k	AKHMETSHIN	99D CMD2	$e^+e^- \rightarrow K_L^0 K_S^0$
1019.38 ± 0.07 ± 0.08	2200	2 AKHMETSHIN	99F CMD2	$e^+e^- \rightarrow \pi^+\pi^- \geq 2\gamma$
1019.51 ± 0.07 ± 0.10	11169	AKHMETSHIN	98 CMD2	$e^+e^- \rightarrow \pi^+\pi^-\pi^0$
1019.5 ± 0.4		BARBERIS	98 OMEG	450 $pp \rightarrow pp2K^+2K^-$
1019.42 ± 0.06	55600	AKHMETSHIN	95 CMD2	$e^+e^- \rightarrow$ hadrons
1019.7 ± 0.3	2012	DAVENPORT	86 MPSF	400 $pA \rightarrow 4KX$
1019.411 ± 0.008	642k	3 DIJKSTRA	86 SPEC	100–200 $\pi^\pm, \bar{p}, p, K^\pm$, on Be
1019.7 ± 0.1 ± 0.1	5079	ALBRECHT	85D ARG	10 $e^+e^- \rightarrow K^+K^-X$
1019.3 ± 0.1	1500	ARENTON	82 AEMS	11.8 polar. $pp \rightarrow KK$
1019.67 ± 0.17	25080	4 PELLINEN	82 RVUE	
1019.52 ± 0.13	3681	BUKIN	78C OLYA	$e^+e^- \rightarrow$ hadrons
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
1019.8 ± 0.7		ARMSTRONG	86 OMEG	85 $\pi^+ / pp \rightarrow \pi^+ / p4Kp$
1020.1 ± 0.11	5526	5 ATKINSON	86 OMEG	20–70 γp
1019.7 ± 1.0		BEBEK	86 CLEO	$e^+e^- \rightarrow \Upsilon(4S)$
1020.9 ± 0.2		5 FRAME	86 OMEG	13 $K^+ p \rightarrow \phi K^+ p$
1021.0 ± 0.2		5 ARMSTRONG	83B OMEG	18.5 $K^- p \rightarrow K^- K^+ \Lambda$
1020.0 ± 0.5		5 ARMSTRONG	83B OMEG	18.5 $K^- p \rightarrow K^- K^+ \Lambda$
1019.7 ± 0.3		5 BARATE	83 GOLI	190 $\pi^- Be \rightarrow 2\mu X$
1019.8 ± 0.2 ± 0.5	766	IVANOV	81 OLYA	1–1.4 $e^+e^- \rightarrow K^+K^-$
1019.4 ± 0.5	337	COOPER	78B HBC	0.7–0.8 $\bar{p}p \rightarrow K_S^0 K_L^0 \pi^+ \pi^-$
1020 ± 1	383	5 BALDI	77 CNTR	10 $\pi^- p \rightarrow \pi^- \phi p$

1018.9 ± 0.6	800	COHEN	77	ASPK	$6 \pi^\pm N \rightarrow K^+ K^- N$
1019.7 ± 0.5	454	KALBFLEISCH	76	HBC	$2.18 K^- p \rightarrow \Lambda K \bar{K}$
1019.4 ± 0.8	984	BESCH	74	CNTR	$2 \gamma p \rightarrow p K^+ K^-$
1020.3 ± 0.4	100	BALLAM	73	HBC	$2.8-9.3 \gamma p$
1019.4 ± 0.7		BINNIE	73B	CNTR	$\pi^- p \rightarrow \phi n$
1019.6 ± 0.5	120	⁶ AGUILAR-...	72B	HBC	$3.9, 4.6 K^- p \rightarrow \Lambda K^+ K^-$
1019.9 ± 0.5	100	⁶ AGUILAR-...	72B	HBC	$3.9, 4.6 K^- p \rightarrow K^- p K^+ K^-$
1020.4 ± 0.5	131	COLLEY	72	HBC	$10 K^+ p \rightarrow K^+ p \phi$
1019.9 ± 0.3	410	STOTTLE...	71	HBC	$2.9 K^- p \rightarrow \Sigma / \Lambda K \bar{K}$

¹ Using a total width of 4.43 ± 0.05 MeV. Systematic uncertainty included.

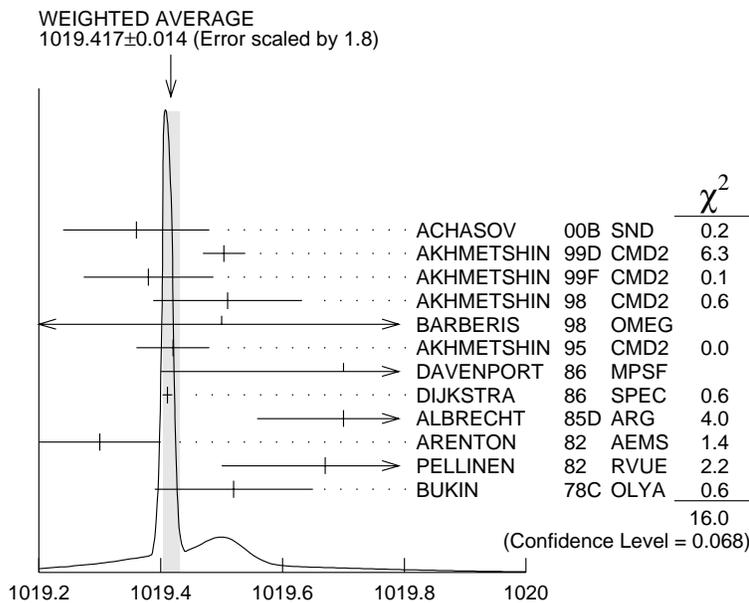
² Using a total width of 4.43 ± 0.05 MeV.

³ Weighted and scaled average of 12 measurements of DIJKSTRA 86.

⁴ PELLINEN 82 review includes AKERLOF 77, DAUM 81, BALDI 77, AYRES 74, DE-GROOT 74.

⁵ Systematic errors not evaluated.

⁶ Mass errors enlarged by us to Γ/\sqrt{N} ; see the note with the $K^*(892)$ mass.



$\phi(1020)$ mass (MeV)

$\phi(1020)$ WIDTH

We average mass and width values only when the systematic errors have been evaluated.

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
4.458±0.032 OUR NEW AVERAGE		[4.43 ± 0.05 MeV	OUR 1998 AVERAGE]	
4.477±0.036±0.022	314k	AKHMETSHIN 99D	CMD2	$e^+e^- \rightarrow K_L^0 K_S^0$
4.44 ±0.09	55600	AKHMETSHIN 95	CMD2	$e^+e^- \rightarrow$ hadrons
4.45 ±0.06	271k	DIJKSTRA	86 SPEC	100 π^- Be
4.5 ±0.7	1500	ARENTON	82 AEMS	11.8 polar. $pp \rightarrow KK$
4.2 ±0.6	766	⁷ IVANOV	81 OLYA	1-1.4 $e^+e^- \rightarrow K^+K^-$
4.3 ±0.6		⁷ CORDIER	80 WIRE	$e^+e^- \rightarrow \pi^+\pi^-\pi^0$
4.36 ±0.29	3681	⁷ BUKIN	78C OLYA	$e^+e^- \rightarrow$ hadrons
4.4 ±0.6	984	⁷ BESCH	74 CNTR	$2\gamma p \rightarrow pK^+K^-$
4.67 ±0.72	681	⁷ BALAKIN	71 OSPK	$e^+e^- \rightarrow$ hadrons
4.09 ±0.29		BIZOT	70 OSPK	$e^+e^- \rightarrow$ hadrons
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
3.6 ±0.8	337	⁷ COOPER	78B HBC	0.7-0.8 $\bar{p}p \rightarrow K_S^0 K_L^0 \pi^+\pi^-$
4.5 ±0.50	1300	^{7,8} AKERLOF	77 SPEC	400 $pA \rightarrow K^+K^-X$
4.5 ±0.8	500	^{7,8} AYRES	74 ASPK	3-6 $\pi^- p \rightarrow K^+K^-n, K^-p \rightarrow K^+K^-\Lambda/\Sigma^0$
3.81 ±0.37		COSME	74B OSPK	$e^+e^- \rightarrow K_L^0 K_S^0$
3.8 ±0.7	454	⁷ BORENSTEIN	72 HBC	2.18 $K^-p \rightarrow K\bar{K}n$

⁷Width errors enlarged by us to $4\Gamma/\sqrt{N}$; see the note with the $K^*(892)$ mass.

⁸Systematic errors not evaluated.

$\phi(1020)$ DECAY MODES

Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_1 K^+K^-	(49.2 ±0.7) %	S=1.2
Γ_2 $K_L^0 K_S^0$	(33.8 ±0.6) %	S=1.2
Γ_3 $\rho\pi + \pi^+\pi^-\pi^0$	(15.5 ±0.6) %	S=1.4
Γ_4 $\rho\pi$		
Γ_5 $\pi^+\pi^-\pi^0$		
Γ_6 $\eta\gamma$	(1.297±0.033) %	S=1.2
Γ_7 $\pi^0\gamma$	(1.26 ±0.10) × 10 ⁻³	
Γ_8 e^+e^-	(2.91 ±0.07) × 10 ⁻⁴	S=1.2
Γ_9 $\mu^+\mu^-$	(3.7 ±0.5) × 10 ⁻⁴	
Γ_{10} ηe^+e^-	(1.3 ^{+0.8} / _{-0.6}) × 10 ⁻⁴	
Γ_{11} $\pi^+\pi^-$	(7.5 ±1.4) × 10 ⁻⁵	
Γ_{12} $\omega\pi^0$	(4.8 ±2.0) × 10 ⁻⁵	
Γ_{13} $\omega\gamma$	< 5 %	CL=84%

Γ_{14}	$\rho\gamma$	< 1.2	$\times 10^{-5}$	CL=90%
Γ_{15}	$\pi^+\pi^-\gamma$	(4.1 ± 1.3)	$\times 10^{-5}$	
Γ_{16}	$f_0(980)\gamma$	(3.4 ± 0.4)	$\times 10^{-4}$	
Γ_{17}	$\pi^0\pi^0\gamma$	(1.08 ± 0.19)	$\times 10^{-4}$	
Γ_{18}	$\pi^+\pi^-\pi^+\pi^-$	< 8.7	$\times 10^{-4}$	CL=90%
Γ_{19}	$\pi^+\pi^+\pi^-\pi^-\pi^0$	< 1.5	$\times 10^{-4}$	CL=95%
Γ_{20}	$\pi^0e^+e^-$	< 1.2	$\times 10^{-4}$	CL=90%
Γ_{21}	$\pi^0\eta\gamma$	(8.6 ± 1.8)	$\times 10^{-5}$	
Γ_{22}	$a_0(980)\gamma$	< 5	$\times 10^{-3}$	CL=90%
Γ_{23}	$\eta'(958)\gamma$	(6.7 ± 3.5)	$\times 10^{-5}$	
Γ_{24}	$\eta\pi^0\pi^0\gamma$	< 2	$\times 10^{-5}$	CL=90%
Γ_{25}	$\mu^+\mu^-\gamma$	(1.4 ± 0.5)	$\times 10^{-5}$	
Γ_{26}	$\rho\gamma\gamma$	< 5	$\times 10^{-4}$	CL=90%
Γ_{27}	$\eta\pi^+\pi^-$	< 3	$\times 10^{-4}$	CL=90%

CONSTRAINED FIT INFORMATION

An overall fit to 15 branching ratios uses 42 measurements and one constraint to determine 8 parameters. The overall fit has a $\chi^2 = 38.2$ for 35 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\langle \delta x_i \delta x_j \rangle / (\delta x_i \delta x_j)$, in percent, from the fit to the branching fractions, $x_i \equiv \Gamma_i / \Gamma_{\text{total}}$. The fit constrains the x_i whose labels appear in this array to sum to one.

x_2	-66						
x_3	-58	-22					
x_6	-19	16	1				
x_7	-14	14	1	11			
x_8	44	-47	-4	-37	-30		
x_9	-8	8	1	6	5	-18	
x_{11}	-6	6	1	5	4	-13	2
	x_1	x_2	x_3	x_6	x_7	x_8	x_9

$\phi(1020)$ PARTIAL WIDTHS

$\Gamma(\eta\gamma)$					Γ_6
VALUE (keV)	DOCUMENT ID	TECN	COMMENT		
••• We do not use the following data for averages, fits, limits, etc. •••					
58.9 \pm 0.5 \pm 2.4	ACHASOV	00	SND $e^+e^- \rightarrow \eta\gamma$		

$\Gamma(\pi^0\gamma)$ Γ_7

VALUE (keV) DOCUMENT ID TECN COMMENT

• • • We do not use the following data for averages, fits, limits, etc. • • •

5.40 ± 0.16 ^{+0.43}/_{-0.40} ACHASOV 00 SND $e^+e^- \rightarrow \pi^0\gamma$

$\Gamma(e^+e^-)$ Γ_8

VALUE (keV) EVTS DOCUMENT ID TECN COMMENT

• • • We do not use the following data for averages, fits, limits, etc. • • •

1.32 ± 0.02 ± 0.04 314k ⁹ AKHMETSHIN 99D CMD2 $e^+e^- \rightarrow K_L^0 K_S^0$

⁹ Using $B(\phi \rightarrow K_L^0 K_S^0) = 0.331 \pm 0.009$.

$\phi(1020) \Gamma(i)\Gamma(e^+e^-)/\Gamma^2(\text{total})$

$\Gamma(e^+e^-) \times \Gamma(K_L^0 K_S^0)/\Gamma_{\text{total}}^2$ $\Gamma_8\Gamma_2/\Gamma^2$

VALUE (units 10⁻⁵) EVTS DOCUMENT ID TECN COMMENT

9.85 ± 0.22 OUR FIT Error includes scale factor of 1.3.

9.756 ± 0.114 ± 0.146 314k ¹⁰ AKHMETSHIN 99D CMD2 $e^+e^- \rightarrow K_L^0 K_S^0$

$\Gamma(e^+e^-) \times [\Gamma(\rho\pi) + \Gamma(\pi^+\pi^-\pi^0)]/\Gamma_{\text{total}}^2$ $\Gamma_8\Gamma_3/\Gamma^2$

VALUE (units 10⁻⁵) EVTS DOCUMENT ID TECN COMMENT

4.50 ± 0.19 OUR FIT Error includes scale factor of 1.3.

4.35 ± 0.27 ± 0.08 11169 ¹⁰ AKHMETSHIN 98 CMD2 $e^+e^- \rightarrow \pi^+\pi^-\pi^0$

$\Gamma(e^+e^-) \times \Gamma(\eta\gamma)/\Gamma_{\text{total}}^2$ $\Gamma_8\Gamma_6/\Gamma^2$

VALUE (units 10⁻⁶) EVTS DOCUMENT ID TECN COMMENT

3.77 ± 0.11 OUR FIT Error includes scale factor of 1.4.

3.84 ± 0.13 OUR AVERAGE Error includes scale factor of 1.5. See the ideogram below.

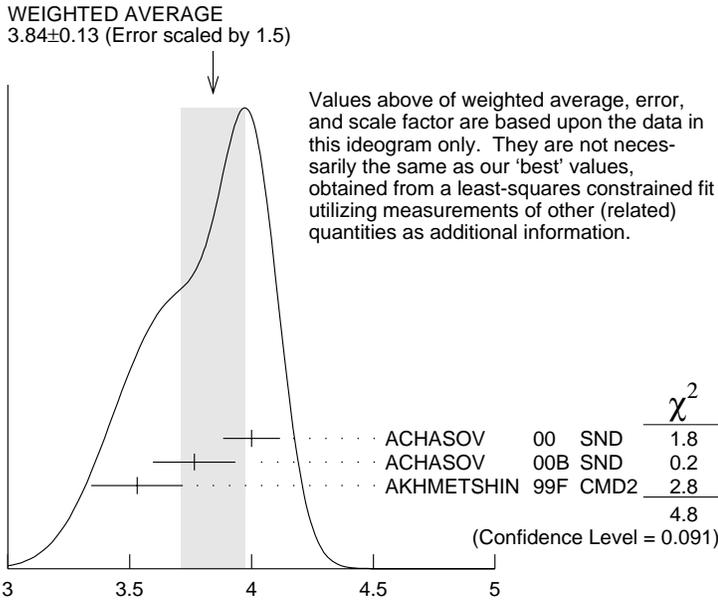
4.00 ± 0.04 ± 0.11 ¹¹ ACHASOV 00 SND $e^+e^- \rightarrow \eta\gamma$

3.765 ± 0.092 ± 0.143 ¹² ACHASOV 00B SND $e^+e^- \rightarrow \eta\gamma$

3.53 ± 0.08 ± 0.17 2200 ^{12,13} AKHMETSHIN 99F CMD2 $e^+e^- \rightarrow \eta\gamma$

• • • We do not use the following data for averages, fits, limits, etc. • • •

3.848 ± 0.036 ± 0.070 ¹⁴ ACHASOV 00B SND $e^+e^- \rightarrow \eta\gamma$



$$\Gamma(e^+e^-) \times \Gamma(\eta\gamma) / \Gamma_{\text{total}}^2 \quad \Gamma_8\Gamma_6 / \Gamma^2$$

$$\Gamma(e^+e^-) \times \Gamma(\pi^0\gamma) / \Gamma_{\text{total}}^2 \quad \Gamma_8\Gamma_7 / \Gamma^2$$

VALUE (units 10^{-7})	DOCUMENT ID	TECN	COMMENT
3.67±0.28 OUR FIT			
3.67±0.10^{+0.27}_{-0.25}	15 ACHASOV	00 SND	$e^+e^- \rightarrow \pi^0\gamma$

$$\Gamma(e^+e^-) \times \Gamma(\mu^+\mu^-) / \Gamma_{\text{total}}^2 \quad \Gamma_8\Gamma_9 / \Gamma^2$$

VALUE (units 10^{-8})	DOCUMENT ID	TECN	COMMENT
10.8±1.4 OUR FIT			
10.8±1.4 OUR AVERAGE			
9.9±1.4±0.9	13 ACHASOV	99c SND	$e^+e^- \rightarrow \mu^+\mu^-$
14.4±3.0	10 VASSERMAN	81 OLYA	$e^+e^- \rightarrow \mu^+\mu^-$
8.6±5.9	10 AUGUSTIN	73 OSPK	$e^+e^- \rightarrow \mu^+\mu^-$

$$\Gamma(e^+e^-) \times \Gamma(\pi^+\pi^-) / \Gamma_{\text{total}}^2 \quad \Gamma_8\Gamma_{11} / \Gamma^2$$

VALUE (units 10^{-8})	DOCUMENT ID	TECN	COMMENT
2.2 ±0.4 OUR FIT			
2.2 ±0.4 OUR AVERAGE			
2.1 ±0.3 ±0.3	13 ACHASOV	00c SND	$e^+e^- \rightarrow \pi^+\pi^-$
1.95 ^{+1.15} _{-0.87}	10 GOLUBEV	86 ND	$e^+e^- \rightarrow \pi^+\pi^-$
6.01 ^{+3.19} _{-2.51}	10 VASSERMAN	81 OLYA	$e^+e^- \rightarrow \pi^+\pi^-$

¹⁰ Recalculated by us from the cross section in the peak.

¹¹ From the $\eta \rightarrow 2\gamma$ decay and using $B(\eta \rightarrow 2\gamma) = (39.21 \pm 0.34) \times 10^{-2}$.

¹² From the $\eta \rightarrow \pi^+\pi^-\pi^0$ decay and using $B(\eta \rightarrow \pi^+\pi^-\pi^0) = (23.1 \pm 0.5) \times 10^{-2}$.

¹³ Recalculated by the authors from the cross section in the peak.

¹⁴ Using various decay modes of the η from ACHASOV 98F, ACHASOV 00, and ACHASOV 00B.

¹⁵ From the $\pi^0 \rightarrow 2\gamma$ decay and using $B(\pi^0 \rightarrow 2\gamma) = (98.798 \pm 0.032) \times 10^{-2}$.

$\phi(1020)$ BRANCHING RATIOS

$\Gamma(K^+ K^-)/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
0.492±0.007 OUR NEW UNCHECKED FIT Error includes scale factor of 1.2. [0.491 ± 0.008 OUR 1998 FIT Scale factor = 1.3]				

0.493±0.010 OUR AVERAGE

0.492±0.012	2913	AKHMETSHIN 95	CMD2	$e^+ e^- \rightarrow K^+ K^-$
0.44 ±0.05	321	KALBFLEISCH 76	HBC	2.18 $K^- p \rightarrow \Lambda K^+ K^-$
0.49 ±0.06	270	DEGROOT 74	HBC	4.2 $K^- p \rightarrow \Lambda \phi$
0.540±0.034	565	BALAKIN 71	OSPK	$e^+ e^- \rightarrow K^+ K^-$
0.48 ±0.04	252	LINDSEY 66	HBC	2.1-2.7 $K^- p \rightarrow \Lambda K^+ K^-$

$\Gamma(K_L^0 K_S^0)/\Gamma_{\text{total}}$ Γ_2/Γ

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
0.338±0.006 OUR NEW UNCHECKED FIT Error includes scale factor of 1.2. [0.341 ± 0.006 OUR 1998 FIT Scale factor = 1.2]				

0.331±0.009 OUR AVERAGE

0.335±0.010	40644	AKHMETSHIN 95	CMD2	$e^+ e^- \rightarrow K_L^0 K_S^0$
0.326±0.035		DOLINSKY 91	ND	$e^+ e^- \rightarrow K_L^0 K_S^0$
0.310±0.024		DRUZHININ 84	ND	$e^+ e^- \rightarrow K_L^0 K_S^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.329±0.006±0.010	314k	¹⁶ AKHMETSHIN 99D	CMD2	$e^+ e^- \rightarrow K_L^0 K_S^0$
0.27 ±0.03	133	KALBFLEISCH 76	HBC	2.18 $K^- p \rightarrow \Lambda K_L^0 K_S^0$
0.257±0.030	95	BALAKIN 71	OSPK	$e^+ e^- \rightarrow K_L^0 K_S^0$
0.40 ±0.04	167	LINDSEY 66	HBC	2.1-2.7 $K^- p \rightarrow \Lambda K_L^0 K_S^0$

$[\Gamma(\rho\pi) + \Gamma(\pi^+ \pi^- \pi^0)]/\Gamma_{\text{total}}$ Γ_3/Γ

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
0.155±0.006 OUR NEW UNCHECKED FIT Error includes scale factor of 1.4. [0.155 ± 0.007 OUR 1998 FIT Scale factor = 1.5]				

0.151±0.009 OUR AVERAGE Error includes scale factor of 1.7.

0.161±0.008	11761	AKHMETSHIN 95	CMD2	$e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$
0.143±0.007		DOLINSKY 91	ND	$e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.145±0.009±0.003	11169	¹⁷ AKHMETSHIN 98	CMD2	$e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$
0.139±0.007		¹⁸ PARROUR 76B	OSPK	$e^+ e^-$

$\Gamma(K_L^0 K_S^0)/\Gamma(K\bar{K})$ $\Gamma_2/(\Gamma_1+\Gamma_2)$

VALUE EVTS DOCUMENT ID TECN COMMENT

0.407^{+0.008}_{-0.007} OUR NEW UNCHECKED FIT Error includes scale factor of 1.2. [0.410 ± 0.007 OUR 1998 FIT Scale factor = 1.2]

0.45 ± 0.04 OUR AVERAGE

0.44 ± 0.07		LONDON	66	HBC	2.24 $K^- p \rightarrow \Lambda K\bar{K}$
0.48 ± 0.07	52	BADIER	65B	HBC	3 $K^- p$
0.40 ± 0.10	34	SCHLEIN	63	HBC	1.95 $K^- p \rightarrow \Lambda K\bar{K}$

$[\Gamma(\rho\pi) + \Gamma(\pi^+ \pi^- \pi^0)]/\Gamma(K\bar{K})$ $\Gamma_3/(\Gamma_1+\Gamma_2)$

VALUE DOCUMENT ID TECN COMMENT

0.186 ± 0.008 OUR NEW UNCHECKED FIT Error includes scale factor of 1.4. [0.187 ± 0.010 OUR 1998 FIT Scale factor = 1.5]

0.24 ± 0.04 OUR AVERAGE

0.237 ± 0.039		CERRADA	77B	HBC	4.2 $K^- p \rightarrow \Lambda 3\pi$
0.30 ± 0.15		LONDON	66	HBC	2.24 $K^- p \rightarrow \Lambda \pi^+ \pi^- \pi^0$

$[\Gamma(\rho\pi) + \Gamma(\pi^+ \pi^- \pi^0)]/\Gamma(K_L^0 K_S^0)$ Γ_3/Γ_2

VALUE EVTS DOCUMENT ID TECN COMMENT

0.457 ± 0.020 OUR NEW UNCHECKED FIT Error includes scale factor of 1.3. [0.456 ± 0.025 OUR 1998 FIT Scale factor = 1.5]

0.51 ± 0.05 OUR AVERAGE

0.56 ± 0.07	3681	BUKIN	78C	OLYA	$e^+ e^- \rightarrow K_L^0 K_S^0, \pi^+ \pi^- \pi^0$
0.47 ± 0.06	516	COSME	74	OSPK	$e^+ e^- \rightarrow \pi^+ \pi^- \pi^0$

$\Gamma(\eta\gamma)/\Gamma(\pi^0\gamma)$ Γ_6/Γ_7

VALUE DOCUMENT ID TECN COMMENT

• • • We do not use the following data for averages, fits, limits, etc. • • •

10.9 ± 0.3 ^{+0.7} _{-0.8}		ACHASOV	00	SND	$e^+ e^- \rightarrow \eta\gamma, \pi^0\gamma$
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$\Gamma(\mu^+ \mu^-)/\Gamma_{\text{total}}$ Γ_9/Γ

VALUE (units 10⁻⁴) DOCUMENT ID TECN COMMENT

2.5 ± 0.4 OUR AVERAGE

2.69 ± 0.46	19	HAYES	71	CNTR	8.3, 9.8 $\gamma C \rightarrow \mu^+ \mu^- X$
2.17 ± 0.60	19	EARLES	70	CNTR	6.0 $\gamma C \rightarrow \mu^+ \mu^- X$

• • • We do not use the following data for averages, fits, limits, etc. • • •

3.30 ± 0.45 ± 0.32	17	ACHASOV	99C	SND	$e^+ e^- \rightarrow \mu^+ \mu^-$
4.83 ± 1.02	20	VASSERMAN	81	OLYA	$e^+ e^- \rightarrow \mu^+ \mu^-$
2.87 ± 1.98	20	AUGUSTIN	73	OSPK	$e^+ e^- \rightarrow \mu^+ \mu^-$

$\Gamma(\eta\gamma)/\Gamma_{\text{total}}$ Γ_6/Γ

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
0.01297 ± 0.00033		OUR NEW UNCHECKED FIT Error includes scale factor of 1.2. [0.0126 ± 0.0006 OUR 1998 FIT Scale factor = 1.1]		

0.0126 ± 0.0004 OUR NEW AVERAGE [0.0126 ± 0.0005 OUR 1998 AVERAGE Scale factor = 1.1]

0.01246 ± 0.00025 ± 0.00057	10k	21	ACHASOV 98F	SND	$e^+e^- \rightarrow 7\gamma$
0.0118 ± 0.0011	279	22	AKHMETSHIN 95	CMD2	$e^+e^- \rightarrow \pi^+\pi^-3\gamma$
0.0130 ± 0.0006		23	DRUZHININ 84	ND	$e^+e^- \rightarrow 3\gamma$
0.014 ± 0.002		24	DRUZHININ 84	ND	$e^+e^- \rightarrow 6\gamma$
0.0088 ± 0.0020	290		KURDADZE 83C	OLYA	$e^+e^- \rightarrow 3\gamma$
0.0135 ± 0.0029			ANDREWS 77	CNTR	6.7-10 γ Cu
0.015 ± 0.004	54	23	COSME 76	OSPK	e^+e^-

• • • We do not use the following data for averages, fits, limits, etc. • • •

0.01338 ± 0.00012 ± 0.00052		25	ACHASOV 00	SND	$e^+e^- \rightarrow \eta\gamma$
0.01287 ± 0.00012 ± 0.00042		26	ACHASOV 00B	SND	$e^+e^- \rightarrow \eta\gamma$
0.01259 ± 0.00030 ± 0.00059		27	ACHASOV 00B	SND	$e^+e^- \rightarrow \eta\gamma$
0.0118 ± 0.0003 ± 0.0006	2200	28	AKHMETSHIN 99F	CMD2	$e^+e^- \rightarrow \eta\gamma$
0.0121 ± 0.0007		29	BENAYOUN 96	RVUE	0.54-1.04 $e^+e^- \rightarrow \eta\gamma$

$\Gamma(\pi^+\pi^-\gamma)/\Gamma_{\text{total}}$ Γ_{15}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
0.41 ± 0.12 ± 0.04		30175	30	AKHMETSHIN 99B	CMD2 $e^+e^- \rightarrow \pi^+\pi^-\gamma$

• • • We do not use the following data for averages, fits, limits, etc. • • •

< 0.3	90	31	AKHMETSHIN 97C	CMD2	$e^+e^- \rightarrow \pi^+\pi^-\gamma$
< 600	90		KALBFLEISCH 75	HBC	2.18 $K^-p \rightarrow \Lambda\pi^+\pi^-\gamma$
< 70	90		COSME 74	OSPK	$e^+e^- \rightarrow \pi^+\pi^-\gamma$
< 400	90		LINDSEY 65	HBC	2.1-2.7 $K^-p \rightarrow \Lambda\pi^+\pi^-\text{neutrals}$

$\Gamma(\omega\gamma)/\Gamma_{\text{total}}$ Γ_{13}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
< 0.05	84	LINDSEY 66	HBC	2.1-2.7 $K^-p \rightarrow \Lambda\pi^+\pi^-\text{neutrals}$

$\Gamma(\rho\gamma)/\Gamma_{\text{total}}$ Γ_{14}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
< 0.12 (CL = 90%)		[< 7×10^{-4} (CL = 90%) OUR 1998 BEST LIMIT]		

< **0.12** 90 32 AKHMETSHIN 99B CMD2 $e^+e^- \rightarrow \pi^+\pi^-\gamma$

• • • We do not use the following data for averages, fits, limits, etc. • • •

< 7	90		AKHMETSHIN 97C	CMD2	$e^+e^- \rightarrow \pi^+\pi^-\gamma$
< 200	84		LINDSEY 66	HBC	2.1-2.7 $K^-p \rightarrow \Lambda\pi^+\pi^-\text{neutrals}$

$\Gamma(e^+e^-)/\Gamma_{\text{total}}$ Γ_8/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT
2.99±0.08 OUR AVERAGE		Error includes scale factor of 1.2.		
2.88±0.09	55600	AKHMETSHIN 95	CMD2	$e^+e^- \rightarrow$ hadrons
3.00±0.21	3681	BUKIN	78C OLYA	$e^+e^- \rightarrow$ hadrons
3.10±0.14		33 PARROUR	76 OSPK	e^+e^-
3.3 ±0.3		COSME	74 OSPK	$e^+e^- \rightarrow$ hadrons
2.81±0.25	681	BALAKIN	71 OSPK	$e^+e^- \rightarrow$ hadrons
3.50±0.27		CHATELUS	71 OSPK	e^+e^-

$\Gamma(\pi^0\gamma)/\Gamma_{\text{total}}$ Γ_7/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID	TECN	COMMENT
1.31 ±0.13 OUR AVERAGE				
1.30 ±0.13		DRUZHININ 84	ND	$e^+e^- \rightarrow 3\gamma$
1.4 ±0.5	32	COSME	76 OSPK	e^+e^-
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
1.226±0.036 ^{+0.096} _{-0.089}		34 ACHASOV 00	SND	$e^+e^- \rightarrow \pi^0\gamma$
1.26 ±0.17		29 BENAYOUN 96	RVUE	0.54-1.04 $e^+e^- \rightarrow \pi^0\gamma$

$\Gamma(\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_{11}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
0.71±0.11±0.09		17 ACHASOV 00C	SND	$e^+e^- \rightarrow \pi^+\pi^-$
0.65 ^{+0.38} _{-0.29}		17 GOLUBEV 86	ND	$e^+e^- \rightarrow \pi^+\pi^-$
2.01 ^{+1.07} _{-0.84}		17 VASSERMAN 81	OLYA	$e^+e^- \rightarrow \pi^+\pi^-$
<6.6	95	BUKIN 78B	OLYA	$e^+e^- \rightarrow \pi^+\pi^-$
<2.7	95	ALVENSLEB... 72	CNTR	6.7 $\gamma C \rightarrow C\pi^+\pi^-$

$\Gamma(\omega\pi^0)/\Gamma_{\text{total}}$ Γ_{12}/Γ

VALUE (units 10^{-5})	DOCUMENT ID	TECN	COMMENT
4.8^{+1.9}_{-1.7}±0.8	ACHASOV 99	SND	$e^+e^- \rightarrow \pi^+\pi^-\pi^0\pi^0$

$\Gamma(K_L^0 K_S^0)/\Gamma(K^+K^-)$ Γ_2/Γ_1

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
0.688^{+0.022}_{-0.019} OUR NEW UNCHECKED FIT		Error includes scale factor of 1.2. [0.695 ± 0.021 OUR 1998 FIT Scale factor = 1.2]		
0.740±0.031 OUR AVERAGE				
0.70 ±0.06	2732	BUKIN 78C	OLYA	$e^+e^- \rightarrow K_L^0 K_S^0$
0.82 ±0.08		LOSTY 78	HBC	4.2 $K^-p \rightarrow \phi$ hyperon
0.71 ±0.05		LAVEN 77	HBC	10 $K^-p \rightarrow K^+K^-\Lambda$
0.71 ±0.08		LYONS 77	HBC	3-4 $K^-p \rightarrow \Lambda\phi$
0.89 ±0.10	144	AGUILAR-...	72B HBC	3.9,4.6 K^-p

$[\Gamma(\rho\pi) + \Gamma(\pi^+\pi^-\pi^0)]/\Gamma(K^+K^-)$ Γ_3/Γ_1

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.314±0.014 OUR NEW UNCHECKED FIT				Error includes scale factor of 1.4. [0.317 ± 0.017 OUR 1998 FIT Scale factor = 1.5]
0.28 ±0.09	34	AGUILAR-...	72B HBC	3.9,4.6 K^-p

$\Gamma(\eta e^+ e^-)/\Gamma_{\text{total}}$ Γ_{10}/Γ

<u>VALUE (units 10⁻⁴)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1.3^{+0.8}_{-0.6}	7	GOLUBEV	85 ND	$e^+e^- \rightarrow \gamma\gamma e^+e^-$

$\Gamma(\eta'(958)\gamma)/\Gamma_{\text{total}}$ Γ_{23}/Γ

<u>VALUE (units 10⁻⁵)</u>	<u>CL%</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
6.7^{+3.4}_{-2.9}±1.0		5	35 AULCHENKO 99	SND	$e^+e^- \rightarrow \pi^+\pi^-3\gamma$

• • • We do not use the following data for averages, fits, limits, etc. • • •

8.2 ^{+2.1} _{-1.9} ±1.1		21	36 AKHMETSHIN 00B	CMD2	$e^+e^- \rightarrow \pi^+\pi^-3\gamma$
<11	90		AULCHENKO 98	SND	$e^+e^- \rightarrow 7\gamma$
12 ⁺⁷ ₋₅ ±2		6	36 AKHMETSHIN 97B	CMD2	$e^+e^- \rightarrow \pi^+\pi^-3\gamma$
<41	90		DRUZHININ 87	ND	$e^+e^- \rightarrow \gamma\eta\pi^+\pi^-$

$\Gamma(\eta\pi^0\pi^0\gamma)/\Gamma_{\text{total}}$ Γ_{24}/Γ

<u>VALUE (units 10⁻⁵)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<2	90	AULCHENKO 98	SND	$e^+e^- \rightarrow 7\gamma$

$\Gamma(\pi^0\pi^0\gamma)/\Gamma_{\text{total}}$ Γ_{17}/Γ

<u>VALUE (units 10⁻⁴)</u>	<u>CL%</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1.08±0.17±0.09		268	AKHMETSHIN 99c	CMD2	$e^+e^- \rightarrow \pi^0\pi^0\gamma$

• • • We do not use the following data for averages, fits, limits, etc. • • •

1.14±0.10±0.12		164	ACHASOV 98i	SND	$e^+e^- \rightarrow 5\gamma$
<10	90		DRUZHININ 87	ND	$e^+e^- \rightarrow 5\gamma$

$\Gamma(\pi^0\pi^0\gamma)/\Gamma(\eta\gamma)$ Γ_{17}/Γ_6

<u>VALUE (units 10⁻²)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.90±0.08±0.07	164	ACHASOV 98i	SND	$e^+e^- \rightarrow 5\gamma$

$\Gamma(\pi^+\pi^+\pi^-\pi^-\pi^0)/\Gamma_{\text{total}}$ Γ_{19}/Γ

<u>VALUE (units 10⁻⁴)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<1.5	95	BARKOV 88	CMD	$e^+e^- \rightarrow \pi^+\pi^-\pi^+\pi^-\pi^0$

$\Gamma(\pi^+\pi^-\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_{18}/Γ

<u>VALUE (units 10⁻⁴)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<8.7	90	CORDIER 79	WIRE	$e^+e^- \rightarrow 4\pi$

$\Gamma(f_0(980)\gamma)/\Gamma_{\text{total}}$						Γ_{16}/Γ
<u>VALUE (units 10^{-4})</u>	<u>CL%</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
3.4 ± 0.4 OUR AVERAGE						
2.90 ± 0.21 ± 1.54			37 AKHMETSHIN 99C	CMD2	$e^+ e^- \rightarrow \pi^+ \pi^- \gamma,$ $\pi^0 \pi^0 \gamma$	
3.42 ± 0.30 ± 0.36		164	38 ACHASOV 98I	SND	$e^+ e^- \rightarrow 5\gamma$	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
1.93 ± 0.46 ± 0.50		27188	39 AKHMETSHIN 99B	CMD2	$e^+ e^- \rightarrow \pi^+ \pi^- \gamma$	
3.05 ± 0.25 ± 0.72		268	40 AKHMETSHIN 99C	CMD2	$e^+ e^- \rightarrow \pi^0 \pi^0 \gamma$	
1.5 ± 0.5		268	41 AKHMETSHIN 99C	CMD2	$e^+ e^- \rightarrow \pi^0 \pi^0 \gamma$	
< 1		90	42 AKHMETSHIN 97C	CMD2	$e^+ e^- \rightarrow \pi^+ \pi^- \gamma$	
< 7		90	43 AKHMETSHIN 97C	CMD2	$e^+ e^- \rightarrow \pi^+ \pi^- \gamma$	
< 20		90	DRUZHININ 87	ND	$e^+ e^- \rightarrow \pi^0 \pi^0 \gamma$	

$\Gamma(\pi^0 e^+ e^-)/\Gamma_{\text{total}}$						Γ_{20}/Γ
<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>		
< 1.2 × 10⁻⁴	90	DOLINSKY 88	ND	$e^+ e^- \rightarrow \pi^0 e^+ e^-$		

$\Gamma(\pi^0 \eta \gamma)/\Gamma_{\text{total}}$						Γ_{21}/Γ
<u>VALUE (units 10^{-4})</u>	<u>CL%</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
0.86 ± 0.18 OUR AVERAGE						
0.90 ± 0.24 ± 0.10		80	AKHMETSHIN 99C	CMD2	$e^+ e^- \rightarrow \eta \pi^0 \gamma$	
0.83 ± 0.23 ± 0.12		20	ACHASOV 98B	SND	$e^+ e^- \rightarrow 5\gamma$	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
< 25		90	DOLINSKY 91	ND	$e^+ e^- \rightarrow \pi^0 \eta \gamma$	

$\Gamma(a_0(980)\gamma)/\Gamma_{\text{total}}$						Γ_{22}/Γ
<u>VALUE (units 10^{-3})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>		
< 5	90	DOLINSKY 91	ND	$e^+ e^- \rightarrow \pi^0 \eta \gamma$		

$\Gamma(\eta'(958)\gamma)/\Gamma(\eta\gamma)$						Γ_{23}/Γ_6
<u>VALUE (units 10^{-3})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>		
6.5 ± 1.8 OUR NEW AVERAGE [(10 ⁺⁵ ₋₄) × 10 ⁻³ OUR 1998 AVERAGE]						
6.5^{+1.7}_{-1.5} ± 0.8	21	AKHMETSHIN 00B	CMD2	$e^+ e^- \rightarrow \pi^+ \pi^- 3\gamma$		
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●						
9.5 ^{+5.2} _{-4.0} ± 1.4	6	44 AKHMETSHIN 97B	CMD2	$e^+ e^- \rightarrow \pi^+ \pi^- 3\gamma$		

$\Gamma(\mu^+ \mu^- \gamma)/\Gamma_{\text{total}}$ Γ_{25}/Γ

VALUE (units 10^{-5})	EVTS	DOCUMENT ID	TECN	COMMENT
1.4 ± 0.5 OUR NEW AVERAGE		[(2.3 ± 1.0) × 10 ⁻⁵		OUR 1998 AVERAGE]
1.43 ± 0.45 ± 0.14	27188	³⁹ AKHMETSHIN 99B	CMD2	$e^+ e^- \rightarrow \mu^+ \mu^- \gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.3 ± 1.0	824 ± 33	⁴⁵ AKHMETSHIN 97C	CMD2	$e^+ e^- \rightarrow \mu^+ \mu^- \gamma$

$\Gamma(\rho\gamma\gamma)/\Gamma_{\text{total}}$ Γ_{26}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
<5	90	AKHMETSHIN 98	CMD2	$e^+ e^- \rightarrow \pi^+ \pi^- \gamma \gamma$

$\Gamma(\eta\pi^+ \pi^-)/\Gamma_{\text{total}}$ Γ_{27}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
<3	90	AKHMETSHIN 98	CMD2	$e^+ e^- \rightarrow \pi^+ \pi^- \gamma \gamma$

¹⁶ Using $\Gamma_{e^+ e^-} = 1.32 \pm 0.04$ keV.

¹⁷ Using $B(\phi \rightarrow e^+ e^-) = (2.99 \pm 0.08) \times 10^{-4}$.

¹⁸ Using $\Gamma(\phi) = 4.1$ MeV. If interference between the $\rho\pi$ and 3π modes is neglected, the fraction of the $\rho\pi$ is more than 80% at the 90% confidence level.

¹⁹ Neglecting interference between resonance and continuum.

²⁰ Recalculated by us using $B(\phi \rightarrow e^+ e^-) = (2.99 \pm 0.08) \times 10^{-4}$.

²¹ Using $B(\phi \rightarrow e^+ e^-) = (2.99 \pm 0.08) \times 10^{-4}$ and $B(\eta \rightarrow 3\pi^0) = (32.2 \pm 0.4) \times 10^{-2}$.

²² From $\pi^+ \pi^- \pi^0$ decay mode of η .

²³ From 2γ decay mode of η .

²⁴ From $3\pi^0$ decay mode of η .

²⁵ From the $\eta \rightarrow 2\gamma$ decay and using $B(\phi \rightarrow e^+ e^-) = (2.99 \pm 0.08) \times 10^{-4}$.

²⁶ Using various decay modes of the η from ACHASOV 98F, ACHASOV 00, and ACHASOV 00B and $B(\phi \rightarrow e^+ e^-) = (2.99 \pm 0.08) \times 10^{-4}$.

²⁷ From the $\eta \rightarrow \pi^+ \pi^- \pi^0$ decay and $B(\phi \rightarrow e^+ e^-) = (2.99 \pm 0.08) \times 10^{-4}$.

²⁸ From $\pi^+ \pi^- \pi^0$ decay mode of η and using $B(\phi \rightarrow e^+ e^-) = (2.99 \pm 0.08) \times 10^{-4}$.

²⁹ Reanalysis of DRUZHININ 84, DOLINSKY 89, and DOLINSKY 91 taking into account a triangle anomaly contribution.

³⁰ For $E_\gamma > 20$ MeV and assuming that $B(\phi(1020) \rightarrow f_0(980)\gamma)$ is negligible. Supersedes AKHMETSHIN 97C.

³¹ For $E_\gamma > 20$ MeV and assuming that $B(\phi(1020) \rightarrow f_0(980)\gamma)$ is negligible.

³² Supersedes AKHMETSHIN 97C.

³³ Using total width 4.2 MeV. They detect 3π mode and observe significant interference with ω tail. This is accounted for in the result quoted above.

³⁴ From the $\pi^0 \rightarrow 2\gamma$ decay and using $B(\phi \rightarrow e^+ e^-) = (2.99 \pm 0.08) \times 10^{-4}$.

³⁵ Using the value $B(\eta' \rightarrow \eta\pi^+ \pi^-) = (43.7 \pm 1.5) \times 10^{-2}$ and $B(\eta \rightarrow \gamma\gamma) = (39.25 \pm 0.31) \times 10^{-2}$.

³⁶ Using the value $B(\phi \rightarrow \eta\gamma) = (1.26 \pm 0.06) \times 10^{-2}$.

³⁷ From the combined fit of the photon spectra in the reactions $e^+ e^- \rightarrow \pi^+ \pi^- \gamma, \pi^0 \pi^0 \gamma$.

³⁸ Assuming that the $\pi^0 \pi^0 \gamma$ final state is completely determined by the $f_0 \gamma$ mechanism, neglecting the decay $B(\phi \rightarrow K\bar{K}\gamma)$ and using $B(f_0 \rightarrow \pi^+ \pi^-) = 2B(f_0 \rightarrow \pi^0 \pi^0)$.

³⁹ For $E_\gamma > 20$ MeV. Supersedes AKHMETSHIN 97C.

⁴⁰ Neglecting other intermediate mechanisms ($\rho\pi, \sigma\gamma$).

- 41 A narrow pole fit taking into account $f_0(980)$ and $f_0(1200)$ intermediate mechanisms.
 42 For destructive interference with the Bremsstrahlung process
 43 For constructive interference with the Bremsstrahlung process
 44 Superseded by AKHMETSHIN 00B.
 45 For $E_\gamma > 20$ MeV.

$\pi^+\pi^-\pi^0 / \rho\pi$ AMPLITUDE RATIO a_1 IN DECAY OF $\phi \rightarrow \pi^+\pi^-\pi^0$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
-0.16 < a_1 < 0.11	90	46 AKHMETSHIN 98	CMD2	$e^+e^- \rightarrow \pi^+\pi^-\gamma\gamma$
46 Dalitz plot analysis of 9735 events taking into account interference between the contact and $\rho\pi$ terms and assuming zero phase for the contact term.				

$\phi(1020)$ REFERENCES

ACHASOV	00	EPJ C12 25	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
ACHASOV	00B	JETP 90 17	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
		Translated from ZHETF 117 22.		
ACHASOV	00C	PL B474 188	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
AKHMETSHIN	00B	PL B473 337	R.R. Akhmetshin <i>et al.</i>	(CMD-2 Collab.)
ACHASOV	99	PL B449 122	M.N. Achasov <i>et al.</i>	
ACHASOV	99C	PL B456 304	M.N. Achasov <i>et al.</i>	
AKHMETSHIN	99B	PL B462 371	R.R. Akhmetshin <i>et al.</i>	(CMD-2 Collab.)
AKHMETSHIN	99C	PL B462 380	R.R. Akhmetshin <i>et al.</i>	(CMD-2 Collab.)
AKHMETSHIN	99D	PL B466 385	R.R. Akhmetshin <i>et al.</i>	
AKHMETSHIN	99F	PL B460 242	R.R. Akhmetshin <i>et al.</i>	(CMD-2 Collab.)
AULCHENKO	99	JETPL 69 97	V.M. Aulchenko <i>et al.</i>	
		Translated from ZETFP 69 87.		
ACHASOV	98B	PL B438 441	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
ACHASOV	98F	JETPL 68 573	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
ACHASOV	98I	PL B440 442	M.N. Achasov <i>et al.</i>	
AKHMETSHIN	98	PL B434 426	R.R. Akhmetshin <i>et al.</i>	
AULCHENKO	98	PL B436 199	V.M. Aulchenko <i>et al.</i>	
BARBERIS	98	PL B432 436	D. Barberis <i>et al.</i>	(Omega expt.)
AKHMETSHIN	97B	PL B415 445	R.R. Akhmetshin <i>et al.</i>	(NOVO, BOST, PITT+)
AKHMETSHIN	97C	PL B415 452	R.R. Akhmetshin <i>et al.</i>	(CMD-2 Collab.)
BENAYOUN	96	ZPHY C72 221	M. Benayoun <i>et al.</i>	(IPNP, NOVO)
AKHMETSHIN	95	PL B364 199	R.R. Akhmetshin <i>et al.</i>	(CMD-2 Collab.)
DOLINSKY	91	PRPL 202 99	S.I. Dolinsky <i>et al.</i>	(NOVO)
DOLINSKY	89	ZPHY C42 511	S.I. Dolinsky <i>et al.</i>	(NOVO)
BARKOV	88	SJNP 47 248	L.M. Barkov <i>et al.</i>	(NOVO)
		Translated from YAF 47 393.		
DOLINSKY	88	SJNP 48 277	S.I. Dolinsky <i>et al.</i>	(NOVO)
		Translated from YAF 48 442.		
DRUZHININ	87	ZPHY C37 1	V.P. Druzhinin <i>et al.</i>	(NOVO)
ARMSTRONG	86	PL 166B 245	T.A. Armstrong <i>et al.</i>	(ATHU, BARI, BIRM+)
ATKINSON	86	ZPHY C30 521	M. Atkinson <i>et al.</i>	(BONN, CERN, GLAS+)
BEBEK	86	PRL 56 1893	C. Bebek <i>et al.</i>	(CLEO Collab.)
DAVENPORT	86	PR 33 2519	T.F. Davenport	(TUFTS, ARIZ, FNAL, FSU, NDAM+)
DIJKSTRA	86	ZPHY C31 375	H. Dijkstra <i>et al.</i>	(ANIK, BRIS, CERN+)
FRAME	86	NP B276 667	D. Frame <i>et al.</i>	(GLAS)
GOLUBEV	86	SJNP 44 409	V.B. Golubev <i>et al.</i>	(NOVO)
		Translated from YAF 44 633.		
ALBRECHT	85D	PL 153B 343	H. Albrecht <i>et al.</i>	(ARGUS Collab.)
GOLUBEV	85	SJNP 41 756	V.B. Golubev <i>et al.</i>	(NOVO)
		Translated from YAF 41 1183.		
DRUZHININ	84	PL 144B 136	V.P. Druzhinin <i>et al.</i>	(NOVO)
ARMSTRONG	83B	NP B224 193	T.A. Armstrong <i>et al.</i>	(BARI, BIRM, CERN+)
BARATE	83	PL 121B 449	R. Barate <i>et al.</i>	(SACL, LOIC, SHMP, IND)
KURDADZE	83C	JETPL 38 366	L.M. Kurdadze <i>et al.</i>	(NOVO)
		Translated from ZETFP 38 306.		

ARENTON	82	PR D25 2241	M.W. Arenton <i>et al.</i>	(ANL, ILL)
PELLINEN	82	PS 25 599	A. Pellinen, M. Roos	(HELS)
DAUM	81	PL 100B 439	C. Daum <i>et al.</i>	(AMST, BRIS, CERN, CRAC+)
IVANOV	81	PL 107B 297	P.M. Ivanov <i>et al.</i>	(NOVO)
Also	82	Private Comm.	S.I. Eidelman	(NOVO)
VASSERMAN	81	PL 99B 62	I.B. Vasserman <i>et al.</i>	(NOVO)
Also	82	SJNP 35 240		
		Translated from YAF 35	352.	
CORDIER	80	NP B172 13	A. Cordier <i>et al.</i>	(LALO)
CORDIER	79	PL 81B 389	A. Cordier <i>et al.</i>	(LALO)
BUKIN	78B	SJNP 27 521	A.D. Bukin <i>et al.</i>	(NOVO)
		Translated from YAF 27	985.	
BUKIN	78C	SJNP 27 516	A.D. Bukin <i>et al.</i>	(NOVO)
		Translated from YAF 27	976.	
COOPER	78B	NP B146 1	A.M. Cooper <i>et al.</i>	(TATA, CERN, CDEF+)
LOSTY	78	NP B133 38	M.J. Losty <i>et al.</i>	(CERN, AMST, NIJM+)
AKERLOF	77	PRL 39 861	C.W. Akerlof <i>et al.</i>	(FNAL, MICH, PURD)
ANDREWS	77	PRL 38 198	D.E. Andrews <i>et al.</i>	(ROCH)
BALDI	77	PL 68B 381	R. Baldi <i>et al.</i>	(GEVA)
CERRADA	77B	NP B126 241	M. Cerrada <i>et al.</i>	(AMST, CERN, NIJM+)
COHEN	77	PRL 38 269	D. Cohen <i>et al.</i>	(ANL)
LAVEN	77	NP B127 43	H. Laven <i>et al.</i>	(AACH3, BERL, CERN, LOIC+)
LYONS	77	NP B125 207	L. Lyons, A.M. Cooper, A.G. Clark	(OXF)
COSME	76	PL 63B 352	G. Cosme <i>et al.</i>	(ORSAY)
KALBFLEISCH	76	PR D13 22	G.R. Kalbfleisch, R.C. Strand, J.W. Chapman	(BNL+)
PARROUR	76	PL 63B 357	G. Parrou <i>et al.</i>	(ORSAY)
PARROUR	76B	PL 63B 362	G. Parrou <i>et al.</i>	(ORSAY)
KALBFLEISCH	75	PR D11 987	G.R. Kalbfleisch, R.C. Strand, J.W. Chapman	(BNL+)
AYRES	74	PRL 32 1463	D.S. Ayres <i>et al.</i>	(ANL)
BESCH	74	NP B70 257	H.J. Besch <i>et al.</i>	(BONN)
COSME	74	PL 48B 155	G. Cosme <i>et al.</i>	(ORSAY)
COSME	74B	PL 48B 159	G. Cosme <i>et al.</i>	(ORSAY)
DEGROOT	74	NP B74 77	A.J. de Groot <i>et al.</i>	(AMST, NIJM)
AUGUSTIN	73	PRL 30 462	J.E. Augustin <i>et al.</i>	(ORSAY)
BALLAM	73	PR D7 3150	J. Ballam <i>et al.</i>	(SLAC, LBL)
BINNIE	73B	PR D8 2789	D.M. Binnie <i>et al.</i>	(LOIC, SHMP)
AGUILAR-...	72B	PR D6 29	M. Aguilar-Benitez <i>et al.</i>	(BNL)
ALVENSLEB...	72	PRL 28 66	H. Alvensleben <i>et al.</i>	(MIT, DESY)
BORENSTEIN	72	PR D5 1559	S.R. Borenstein <i>et al.</i>	(BNL, MICH)
COLLEY	72	NP B50 1	D.C. Colley <i>et al.</i>	(BIRM, GLAS)
BALAKIN	71	PL 34B 328	V.E. Balakin <i>et al.</i>	(NOVO)
CHATELUS	71	Thesis LAL 1247	Y. Chatelus	(STRB)
Also	70	PL 32 416	J.C. Bizot <i>et al.</i>	(ORSAY)
HAYES	71	PR D4 899	S. Hayes <i>et al.</i>	(CORN)
STOTTLE...	71	Thesis ORO 2504 170	A.R. Stottlemeyer	(UMD)
BIZOT	70	PL 32 416	J.C. Bizot <i>et al.</i>	(ORSAY)
Also	69	Liverpool Sym. 69	J.P. Perez-y-Jorba	
EARLES	70	PRL 25 1312	D.R. Earles <i>et al.</i>	(NEAS)
LINDSEY	66	PR 147 913	J.S. Lindsey, G. Smith	(LRL)
LONDON	66	PR 143 1034	G.W. London <i>et al.</i>	(BNL, SYRA) IGJPC
BADIER	65B	PL 17 337	J. Badier <i>et al.</i>	(EPOL, SACL, AMST)
LINDSEY	65	PRL 15 221	J.S. Lindsey, G.A. Smith	(LRL)
LINDSEY	65	data included in LINDSEY 66.		
SCHLEIN	63	PRL 10 368	P.E. Schlein <i>et al.</i>	(UCLA) IGJP

OTHER RELATED PAPERS

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ACHASOV	98C	PR D57 1987	N.N. Achasov <i>et al.</i>	
OLLER	98B	PL B426 7	J.A. Oller	
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ACHASOV	97D	PR D56 203	N.N. Achasov <i>et al.</i>	
ACHASOV	95	PLB 363 106	N.N. Achasov, V.V. Gubin	(NOVM)
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